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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte ROBERT SHEFFIELD
and EILEEN GOULET

Appeal 2009-013404
Application 10/667,491
Technology Center 1700

Before MICHAEL P. COLAIANNI, LINDA M. GAUDETTE, and MARK NAGUMO, *Administrative Patent Judges*.

NAGUMO, *Administrative Patent Judge*.

DECISION ON APPEAL[1]

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[1] The two-month time period for filing an appeal or commencing a civil action, as recited in 37 C.F.R. § 1.304, or for filing a request for rehearing, as recited in 37 C.F.R. § 41.52, begins to run from the "MAIL DATE" (paper delivery mode) or the "NOTIFICATION DATE" (electronic delivery mode) shown on the PTOL-90A cover letter attached to this decision.

A. Introduction[2]

Robert Sheffield and Eileen Goulet ("Sheffield") timely appeal under 35 U.S.C. § 134(a) from the final rejection[3] of claims 1, 2, 4-6, 19, and 20. We have jurisdiction under 35 U.S.C. § 6. We AFFIRM.

The appealed subject matter relates to a method of improving the signal performance of circuit boards by reducing the surface roughness of the conductive traces. At signal frequencies of 1 GHz (10^9 s^{-1}), the so-called "skin-effect" is said to force electrons to the surface of the conductor in a layer approximately 2 microns thick (2 μm; about 80 micro-inches ("μ-in")), which is called the "skin depth." (Spec. 1, ll. 12-21.) The skin depth decreases as the signal frequency increases. (*Id.* at ll. 19-21.) The presence of roughness on the scale of the skin depth is said to increase the mean free path traveled by the electrons transmitting the high frequency signal, and thus to increase the resistance to the flow of current and to increase the transmission time. (*Id.* at 2, ll. 1-7.) Reducing the surface roughness by polishing is said to improve the signal performance in conductive circuit traces at high frequencies. (*Id.* at ll. 15-20.)

This is the second time this application, with similar claims, has come before the Board. In the last appeal,[4] we AFFIRMED-IN-PART rejections

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[2] Application 10/667,491, *Reduced Circuit Trace Roughness for Improved Signal Performance*, filed 23 September 2003. The specification is referred to as the "491 Specification," and is cited as "Spec." The real party in interest is listed as Nortel Networks Ltd., of Canada. (Appeal Brief filed 23 February 2009 ("App. Br.") at 1-2.)

[3] Office action mailed 21 October 2008 ("Final Rejection"; cited as "FR").

[4] *Ex parte Sheffield*, fd2007-3676 (BPAI 2008) ("Sheffield-1").

of somewhat more broadly claimed subject matter as anticipated by Tanaka, but reversed the rejections of claims that specified a surface roughness of no more than 20-, 10-, or 5-μ-in RMS (hereinafter we drop the "RMS").

Representative Claim 1 reads:

> 1. A method for improving performance of a signal transmitted via a conductive circuit trace of a circuit board, the method comprising the step of:
>
> providing a layer of the circuit board having the conductive circuit trace on a surface thereof; and
>
> reducing a surface roughness of at least one surface of the conductive circuit trace on the surface of the circuit board layer so as to improve performance of a signal transmitted via the conductive circuit trace,
>
> *wherein the surface roughness of the at least one surface is reduced to no more than 20 microinches root-mean-squared (RMS).*

(Claims App., Br. 22; indentation, paragraphing, and emphasis added.)

The Examiner has maintained the following grounds of rejection:[5]

A. Claims 1, 2, 4-6, 19, and 20 stand rejected under 35 U.S.C. § 103(a) in view of Tanaka.[6]

B. Claims 1, 2, 4-6, 19, and 20 stand rejected under 35 U.S.C. § 103(a) in view of the combined teachings of Tanaka and Nagai.[7]

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[5] Examiner's Answer mailed 13 April 2009 ("Ans.").

[6] Tadashi Tanaka et al., *Bonded Ceramic Metal Composite Substrate, Circuit Board Constructed Therewith and Methods for Production Thereof*, U.S. Patent 4,959,507 (1990).

[7] Hifumi Nagai et al., *Copper-Alloy Foil to be Used for Laminate Sheet*, U.S. Patent Application Publication US 2002/0155021 A1 (24 October 2002), based on an application filed 30 January 2002.

B. Discussion

Findings of fact throughout this Opinion are supported by a preponderance of the evidence of record.

Sheffield argues that the Examiner failed to establish a prima facie case of obviousness in both rejections because the teachings of Tanaka and of Nagai to provide limited surface roughness do not "narrowly encompass" the roughness of no more than 20 μ-in recited in claim 1. Rather, Sheffield argues, Tanaka teaches a median roughness of no more than 254 μ-in, which is more than 12 times the roughness required by the claims. (Br. 9.) Similarly, according to Sheffield, Nagai teaches a surface roughness of no more than 97 μ-in, more than four times the roughness of 20 μ-in required by claim 1. (*Id.* at 16.) Sheffield argues that the ranges taught by the references are "significantly larger" than the ranges recited in the claims. (*Id.* at 9 and 16.) Moreover, Sheffield argues, the reduction of the skin effect by polishing is an unexpected result "not taught or even contemplated by Tanaka" (*id.* at para. bridging 9-10) or Nagai (*id.* at para. bridging 18-19). The Examiner's conclusion that the differences would have been obvious has, in Sheffield's view, no basis in fact.

The Examiner finds that Tanaka discloses circuit traces having a median surface roughness of 1 μm. (Ans. 3, citing Tanaka, col. 3, ll. 9-12.) The Examiner equates 1 μm to 254 μ-in. (*Id.* at 3, 3d para.) The Examiner also finds that Nagai discloses that "2 micrometer or less of surface roughness in terms of the ten-point average surface-roughness (Rz) attains the desired high-frequency performance." (*Id.* at 5, 3d para., citing Nagai, para. 28.) The Examiner equates 2 μm to about 97 μ-in. (*Id.* at 5, 3d para.)

In both cases, the Examiner, citing cases such as *In re Peterson*, 315 F.3d 1325 (Fed. Cir. 2003) argues that because the range disclosed by the references "encompasses" the range recited in claim 1, the smaller range would have been obvious. (Ans. 4, 7.)

We observe first a somewhat disconcerting cluster of conversion errors that neither the Examiner nor Sheffield appears to have recognized, despite Sheffield's previous reliance on the proper conversion factors for the critical roughness recited in the claims which are:

20 μ-in	0.5 μm	(claim 1)
10 μ-in	0.25 μm	(claim 4)
5 μ-in	0.13 μm	(claim 5)

(*See* the Brief filed 15 September 2006, para. bridging 10-11; cited in Sheffield-1 at 10, first full para.) Thus, a surface roughness of about 1 μm corresponds to a roughness of about 40 μ-in, and a surface roughness of about 2 μm corresponds to a roughness of about 80 μ-in.[8] Since the correct values do not change the essence of either the Examiner's or Sheffield's arguments, the errors appear to be harmless.

[8] The origin of the error equating 1 μm to 254 μ-in may lie in Sheffield-1 at page 6, FF 13—a conversion factor that was never used and, ironically, the only erroneous conversion factor reported in that Opinion. The author of that typographical error apologizes, but cautions that calculations should always be checked before they are used. The inconsistencies of Tanaka's reported roughness and of Nagai's reported roughness, when converted to μ-in by the Examiner, should have been a warning signal. We can only speculate about the origin of the error equating 2 μm to 97 μ-in: perhaps the numerals in 79 μ-in [the slide-rule or calculator value] were inadvertently transposed.

Sheffield's arguments against a prima facie case of obviousness are not persuasive of harmful error in the Examiner's rejections. In a prima facie case of obviousness, "[b]oth the suggestion and the reasonable expectation of success must be founded in the prior art, not in the applicant's disclosure." *In re Vaeck*, 947 F.2d 488, 493 (Fed. Cir. 1991) (citation omitted). In the present case, both Tanaka and Nagai teach maximum average surface roughness values for copper circuit sheets or foils on printed circuit boards. Neither reference teaches a minimum value of average surface roughness, below which the desired property cannot be obtained. Tanaka teaches that solder wettability is improved with copper foils having a median roughness of less than 1 μm [about 40 μ-in]. (Tanaka, col. 7, ll. 1-4.) According to Tanaka, mechanical and chemical polishing may be used, with chemical polishing being preferred because it better removes particles of resist. (*Id.* at col. 4, ll. 45-67.) Nagai teaches that improved conductivity at high frequencies (≥ 1 GHz) is obtained by reducing the skin effect by providing an average surface roughness of less than 2 μm [about 80 μ-in]. (Nagai at 3 [0028]).) According to Nagai, chemical or electrolytic polishing may be used to obtain the desired fine surface roughness. (*Id.*) Neither Tanaka nor Nagai indicates that substantially lower values of average surface roughness cannot be obtained by conventional techniques.

The supporting disclosure in the 491 Specification similarly provides no indication that conventional techniques of polishing are not capable of yielding an average roughness of 5-20 μ-in [0.13-0.5 μm]. Sheffield has not drawn our attention to any disclosure or to any general knowledge of those

skilled in the art to the contrary. Polishing techniques are said to include electropolishing, chemical polishing, electroplating, or vacuum deposition (Spec. 3, ll. 20-22), as well as chemical mechanical polishing, and mechanical polishing (*id.* at 14, ll. 18-22). Notably, the 491 Specification provides no working examples of polishing or of improved signal performance at high frequencies.

On the present record, both references provide a suggestion to polish copper circuit traces to less than a certain value of average roughness, without a lower limit. In other words, both references teach that smoother is better. Moreover, there is no indication in the record on appeal that achieving lower levels of roughness, at least down to 20-, 10-, and 5 μ-in, required by claims 1, 4, and 5, respectively, would have been regarded as requiring undue experimentation. We conclude that the two-prong suggestion-expectation test for prima facie obviousness described by the court in *Vaeck* has been satisfied.

The Examiner's reliance on *Peterson*, 315 F.3d at 1329–30[9] tacitly assumes that the ranges disclosed by the references would have been recognized as being sufficiently similar to those recited in the claims that what is taught in one part of the range would have been expected to provide similar (or predictable) results in another part of the range. While this assumption is not always valid, whether or not it is necessary to argue expressly that the similarity would have been recognized by persons having

[9] "Selecting a narrow range from *within* a somewhat broader range disclosed in a prior art reference is no less obvious than identifying a range that simply overlaps a disclosed range."

ordinary skill in the art depends on the facts and circumstances of each case. Given the unchallenged enablement of polishing to the required 5-20 μ-in roughness, and the general teaching that smoother is better, the omission of such an argument was harmless. We conclude that Sheffield has not shown harmful error in the Examiner's prima facie case of obviousness of claim 1.

Sheffield's arguments for the separate patentability of claims 2 and 4-6 (Br. 13, para. bridging 19-20; Reply 8) are not persuasive. Sheffield argues that certain polishing techniques recited in claim 2 are not taught or suggested by either reference. (*Id.*) But claim 2 also recites chemical and mechanical polishing, which are taught by Tanaka, and electrochemical polishing, which, along with chemical polishing, are taught by Nagai. The arguments for claims 4 and 5 merely recite the roughness values (10 and 5 μ-in, respectively) required. (*Id.*) However, merely pointing out what a claim recites does not, under USPTO regulations governing appeals to the Board, constitute an argument for separate patentability. 37 C.F.R. § 41.37(c)(1)(vii) (last sentence). Sheffield also argues that the limitations recited in claim 6 are neither taught nor suggested. (*Id.*) Both Tanaka and Nagai, however, teach polishing the exposed surface of the copper trace on a printed circuit board. Sheffield has not explained why this is not polishing "a surface parallel and distal to a surface of the circuit board," as recited in claim 6. We therefore reject Sheffield's arguments that a prima facie case of obviousness has not been established for dependent claims 2 and 4-6 in either appealed rejection.

Sheffield's arguments for patentability based on unexpected results (App. Br. 9-12) are effective with respect to Tanaka, which does not teach or

suggest some significant further improvement at lower levels of roughness. We therefore REVERSE the rejection over Tanaka.

Nagai, however, is concerned with the same problem, the transmission of electrical signals at frequencies greater that 1 GHz in copper foils on printed circuit boards. Nagai recognizes expressly that "[f]ine surface roughness is, therefore, necessary for conductive material used in a high-frequency circuit." (Nagai 3 [0028].) Sheffield has not directed our attention to any experimental data in the record on appeal, nor to any credible evidence of what persons having ordinary skill in the art would have expected based on the teachings of Nagai. As our reviewing court has instructed,

> in order to properly evaluate whether a superior property was unexpected, the court should have considered what properties were expected. *Merck [& Co. Inc. v. Biocraft Laboratories Inc.*], 874 F.2d [804] at 808 [(1989)]. Here, [Appellants'] evidence must fail because the record is devoid of *any* evidence of what the skilled artisan would have expected.

Pfizer, Inc. v. Apotex, Inc., 480 F.3d 1348, 1371 (Fed. Cir. 2007). Sheffield has not explained the conditions (e.g., frequency, roughness) under which the reported "up to 20% improvement" in signal for lateral smoothing, or the "50% or more" improvement resulting from transverse polishing (Spec. 11, ll. 1-3) were obtained. Nor has Sheffield come forward with credible evidence supporting the argument that "Nagai teaches nothing more than a traditional technique." (Br. 19, l. 3; Reply 7, 1st full para.) Accordingly, neither the Examiner nor the Board has been placed in a position to evaluate whether such an improvement is probative of unexpected results with respect to any of the appealed claims.

We conclude that Sheffield has not shown harmful error in the rejection of the appealed claims in view of the combined teachings of Tanaka and Nagai.

C. Order

We REVERSE the rejection of claims 1, 2, 4-6, 19, and 20 under 35 U.S.C. § 103(a) in view of Tanaka.

We AFFIRM the rejection of claims 1, 2, 4-6, 19, and 20 under 35 U.S.C. § 103(a) in view of the combined teachings of Tanaka and Nagai.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a).

AFFIRMED

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